

NASA TECH BRIEF

Lyndon B. Johnson Space Center



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An Improved Method for Obtaining a Normalized Junction Temperature for Semiconductors: A Concept

The problem:

To date, reliability of semiconductors has been determined through laborious, expensive, and time consuming computations. Typically a knowledge of thermal resistance and of actual junction temperature are required to compute the basic reliability indicator, the normalized junction temperature. For a trade-off study of various stress loads and temperatures to which the device will be subjected, it is also necessary to calculate the actual power dissipation of the device.

The solution:

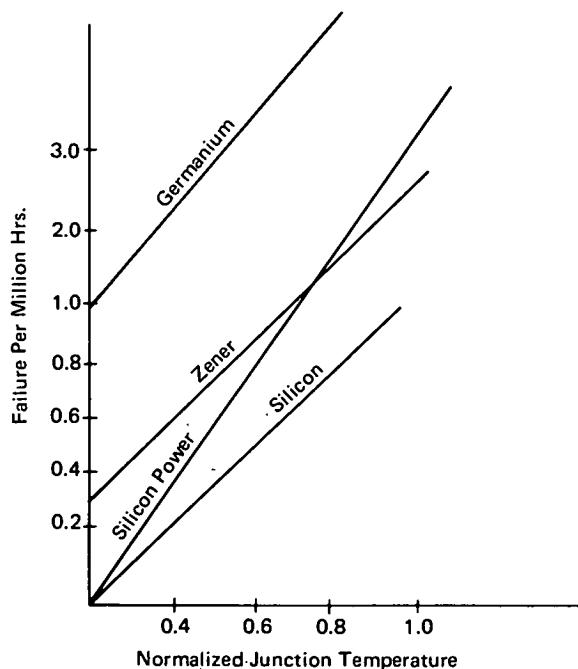
Most of these calculations have become unnecessary as a result of a recently developed method. No longer is there a need to know the thermal resistance and actual power dissipation of the device to determine the normalized junction temperature.

How it's done:

Failure rates for different semiconductor devices have already been established (see figure) as a function of normalized junction temperature. Hence, the only question remaining is to determine the value of normalized junction temperature for any given device. The equation for normalized junction temperature T_n is given by

$$T_n = \frac{(T_A - T_S) + S(T_{j(max)} - T_A)}{T_{j(max)} - T_S}$$

where T_A is the ambient temperature; T_S is the temperature at which the power derating begins, usually at 25° C; S is the stress ratio; and $T_{j(max)}$ is the maximum rated junction temperature. With $T_S = 25^\circ \text{C}$, this equation has been processed by computer for all practical combinations of T_A , S , and $T_{j(max)}$. As a result, about 1600 values of T_n have been printed out. Now failure rate for a given semiconductor device is simply determined by reading the value of T_n from the printout for any given combination of T_A , S , and $T_{j(max)}$ and obtaining the corresponding failure rate from the graph (see figure).



Failure Rate For Different Semiconductor Devices
As A Function Of Normalized Junction Temperature

(continued overleaf)

Note:

Requests for further information may be directed to:

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Patent status:

NASA has decided not to apply for a patent.

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